Statement of Teaching

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I. Background About Myself

I have been a lecturer at UCSB since completing my PhD in Electrical and Computer Engineering in 2004. From 3/2004–9/2006, I taught courses (non-senate lecturer) in the ECE Department and College of Engineering and at the same time worked as a post-doc in ECE Prof. Umesh Mishra's group. From 9/2006–6/2011, I was a non-senate lecturer in both the ECE Department and in the College of Creative Studies Physics Program. In July 2011, I became a Continuing Lecturer in the ECE Department, a position that I held until I became an LSOE in July 2017. From 9/2011 – 12/2014, I also served as a lecturer (non-senate) in the Technology and Management Program.

Since 2007, I have also run a small IP consultancy business, primarily helping local start-up companies develop and manage their IP portfolios. My work in this area formed the basis for most of the courses I taught in the TMP program, and has also enabled me to introduce material to students in the UCSB Engineering Capstone programs that are highly relevant to their careers.

While the following sections of this Statement of Teaching focus on my work during the current review period, in this section I provide a description of some of my major responsibilities and achievements over the course of my career as a lecturer at UCSB.

A. Semiconductor Processing and IC Design Coursework for Undergraduates

When I first began work as a lecturer in 2004, despite having a world class research effort and graduate program in semiconductor devices and materials, the ECE Department at UCSB had very little in the way of offerings for undergraduates in this field. While we did offer an elective sequence in semiconductor processing and physical IC design and fabrication, ECE 124B/C (which has since been renumbered to ECE 120A/B), the largest enrollment that these courses had seen to that point was about 11-12 students in ECE 124B and about 4-5 students in ECE 124C.

The ECE 120A/B (formerly 124B/C) sequence gives undergraduates the chance to leverage our world class cleanroom facilities to fabricate and test Silicon NMOS-based devices and integrated circuits. I took over this sequence in Spring 2004 and completely revamped the course material and labs. The first time I taught ECE 124C (Spring 2004), only 5 students were enrolled. The following year, 22 students enrolled in ECE 124B in W2005 and 21 continued on to ECE 124C in S2006. That year, the undergraduates in our department also selected me to receive the ECE Department Outstanding Faculty Award for Excellence in Teaching.

I have continued to teach that sequence to this date, and over time it has continued to become more and more popular. This past Winter, a record 40 undergraduates enrolled in ECE 120A, and before the shelter-in-place order was enacted there had been 32 students enrolled in ECE 120B for the Spring (about half the class opted to drop and take the course in 2021 so that they would be able to work in the Instructional Cleanroom).

B. Electrical Engineering Senior Capstone Projects

I was first placed in charge of the EE Capstone Senior Project course sequence (ECE 188) in the 2009-2010 academic year and have run it ever since. Prior to 2009, this sequence had only been offered somewhat informally, and the ECE department was interested in expanding it and making it a requirement for all EE students in future years. Because the sequence was intended to attract students interested in a wide range of EE topics, the goal was to structure the course in such a way that students would have a wide array of project options to choose from. Furthermore, due to budget constraints, I was only allotted a $5000 annual budget for all projects.

After exploring a number of options for structuring the course, I chose one in which projects would be offered by research groups on campus or by local industry partners. I solicit projects from potential sponsors, students choose one of these projects to work on, and each group is assigned a mentor who, in addition to myself, provides them with technical guidance. The project sponsor typically also provides funding for the project, although in some cases I've had to find other sources of funding. My primary responsibilities are then to identify projects and find mentors, provide general technical mentorship to all groups, and serve as somewhat of a project manager to each group, ensuring that design plans and specifications are properly defined, and that goals and milestones are achieved in a timely manner. Along with one other instructor in Computer Engineering and one in Mechanical Engineering, I also plan and organize an end-of year Engineering Design Expo featuring all of our Capstone projects that is typically attended by about 500-600 people from local industry and from our campus. Capstone teams all present posters and demo their projects, and several teams give TED-type talks to a large audience in Campbell Hall. A panel of experts from academia and industry judge the projects and select award winners. This event is a great source of pride for the students who participate, and helps us engage with and further solidify our relationships with all of our industry partners, many of whom hire lots of our graduating students.

I've tried to model the course as close as possible to an industry experience, in which teams report to a project manager and have to meet certain goals and milestones throughout the course of a project. In lecture, in addition to going over technical aspects of the projects, I cover topics such as project management, project planning and Gantt charts, defining specifications, prototyping, engineering finance, branding, and patents and intellectual property. I also schedule 2 presentations and require the submission of 1 design report and 1 prototype demo per team each quarter. I feel that it is important for students to leave university knowing how to present their work well. Moreover, it has been my observation that having the students give formal presentations somewhat regularly forces them to organize their ideas and results in substantially better outcomes in the engineering work on their projects.

The first two years I ran the course, there were 8-9 students working on 3 projects each year. Since then, the number of enrolled students as well as both the number and complexity of projects completed each year has steadily increased. While the course was an elective sequence (through the 2018-2019 academic year), enrollment grew to about 20-25 students working on 6-7 projects each year, and also began to include multi-disciplinary projects completed in conjunction with students in the Mechanical and Computer Engineering programs. In 2019-2020, the first year that this course sequence was required for all of our students, there were 46 students enrolled. Projects have been directed to a wide range of areas within EE, including embedded systems, image processing, digital and analog circuit design, signal processing, sensors, wireless communication, antenna systems, optical detection, control systems, and many others. Furthermore, in addition to research group and industry sponsored projects, the pool of projects has also been expanded to include student-defined projects as well as competitions, including the SpaceX Levitating Hyperloop Pod Competition and the FAR/Mars rocket competition. Descriptions, photos, and videos of all of the projects from the last 3 years can be found at: https://capstone.engineering.ucsb.edu/projects

This course has been quite a challenge to build and maintain. In order to find projects for the students, I solicit faculty members, researchers, companies, and individual sponsors to identify potential projects that would be suitable for students and that the sponsor is willing to fund. Because the projects cover a wide array of sub-fields within the electrical engineering discipline, it is often quite a challenge to properly identify projects that are suitable in scope for the course and to choose/identify a technical mentor for the group (the latter has been particularly difficult for projects that are sponsored by research groups outside of the ECE department).

The (singe disciplinary) EE projects that we have offered have typically include about 3-5 students each. Most projects include some combination of significant hardware and software design and span a variety of areas within the field of Electrical Engineering. A few examples of some of the EE projects that have been successfully completed include machine learning (ML) based systems for recognition of surgical tools in arthroscopic surgery videos, a multi-transducer array for detecting the location of listeners around a speaker, an electric airplane with autonomous flight capabilities, a bioluminescence detection system for implementation in medical diagnostic tools, ground penetrating radar (GPR) systems for detection of buried objects, a smart-phone controlled switch with proximity sensing capabilities for automating controls of household electronics, a solar tracking system for improving the overall efficiency of photovoltaic and thermoelectric power generators, and a portable electrochemical potentiostat for detection of analytes in solution. Additional details of projects run during the last 2 years are provided in the sections below.

Adding multi-disciplinary projects was a challenging endeavor that we spent a number of years refining, as further described below, but the effort has also been highly successful. Beginning in about 2011, many of our EE and ME project sponsors began to inquire about the possibility of adding EE students to an ME team, or vice-versa. Initially we were unsuccessful at making such a model work because EE students felt that their contributions to an ME project would be secondary to the main goals of the project, and ME students felt the same about EE projects. Eventually, during the 2013-2014 academic year, we partnered with FLIR to offer two projects that each included a substantial EE component and a substantial ME component, and so these projects each included a full EE and a full ME team. One of these projects was particularly successful. The students built a throwable sensor that could be tossed into a hazardous environment, such as a burning building, and allow first responders to assess the environment from the outside before entering. The device was spherical and included 12 FLIR IR camera sensors around the periphery. Once the device was tossed and subsequently landed, a 3-axis accelerometer determined the orientation of the device and would activate IR cameras appropriately located for the given orientation to begin taking video/photos and sending the images wirelessly to a user device such as a laptop.

In the 2014-2015 academic year, we ran two more EE/ME interdisciplinary projects with FLIR. One was an actively stabilized gimbal system for mounting one of FLIR's camera sensors to a drone and transmitting the video data wirelessly. The other was a helmet mounted camera and heads up display designed to provide firefighters with a hands-free device allowing for increased visibility near a fire. Based on many of our learnings from the previous year, we were able to guide the teams to an even greater level of success than the previous year, with both teams completing working prototypes. The prototypes were well enough designed that FLIR was able to take both to partner companies and leverage them to form partnerships to commercialize the technologies. Both have since been commercialized and are available for purchase. A video of the helmet mounted device can be found at:

http://www.ece.ucsb.edu/courses/ECE188/188_F14Ilan/Posters/FLIR%20Firefighter%20Animation.mp4

For 2015-2016, in addition to offering two EE/ME projects in partnership with FLIR, we also added two multi-disciplinary projects that included Computer Engineering students in addition to EE and ME students. One of these projects, for which we partnered with SONOS, was a wireless speaker integrated with a recessed lightbulb. Because of the added expertise and resources provided by the CE team, we were able to complete a significantly more sophisticated form-factor PCB for all the electronics, resulting in a product that looked fantastic as a lightbulb and sounded amazing as a speaker. The other 2015-2016 multi-disciplinary project included our first 20-student team working on a Hyperloop Pod for the SpaceX competition. Based on that team's initial design and prototype work, we were one of 22 teams (from over 1200 initial entries) selected by SpaceX to build a pod and compete in their competition. This project continued on with new teams taking over for 2 additional years. The 2016-2017 Hyperloop team and I worked with the Santa Barbara MOXI Museum on a UCSB Hyperloop exhibit, which was on display for the first year that the museum was open. Our 2017-2018 team was extremely successful, as we won the 2018 SpaceX Levitating Hyperloop Pod Competition! Videos about our 2016 Hyperloop project and SONOS lightbulb speaker projects can be found at the following URLs, below which are some photographs from the 2018 SpaceX Hyperloop Pod Competition.

https://www.youtube.com/watch?v=1RYfvB1G71Q
https://www.youtube.com/watch?v=G87j7oIKZm0

In addition to supporting the UCSB Hyperloop Team through several competitions at SpaceX, I also served as an advisory board / steering committee member for and attended the 1st HARP International Conference on Hyperloop Transportation and Related Technologies (LoopTransport 2018), which was held the day after the finals of the 2018 Hyperloop competition. Students from our team also presented their winning pod as well as gave demonstrations on magnetic levitation at the conference.

Following these successes, in the last 4 years we have continued to have a high level of success with many of our multi-disciplinary projects. In addition to several other projects run with SONOS and FLIR, we've had teams build a surgical training tool (project sponsored by TrueDigital Surgery), a therapy device for infants and toddlers with cerebral palsy, an assistive walking device for individuals with reduced mobility, and a rocket booster engine.

In my opinion, the EE Capstone course has had quite a substantial impact on the participating students' undergraduate education, and has also proven to be a major asset to the UCSB ECE department. The students have gotten a chance to work on some real-world design problems with guidance from one or more mentors who are knowledgeable in the field. Many of the students have established professional relationships with their mentors or their mentors' company/organization, and have been hired to work at the company upon graduation. About 6-7 projects have resulted in published papers and/or conference presentations. A potentiostat built by students during the 2009-2010 academic year (dubbed the "CheapStat") is currently in use in several dozen labs around the world. Several teams have entered their projects in the UCSB New Venture Competition, with three of those teams starting companies based on their projects. At least five of the projects have resulted in products that have been commercialized. Based on the model that we have developed and continue to expand, I believe we will continue adding to these successes in the future.

C. Technology Management Program

I became involved with the Technology Management Program through a combination of my outside work in Intellectual Property and through my involvement with the New Venture Competition (NVC). Beginning in 2011-2012, I began supporting and mentoring teams entering the UCSB New Venture Competition. My primary objective was to provide opportunities for undergraduate engineering students to develop technology through the knowledge and skills acquired in their engineering program and then learn how to start a business and commercialize their products. In 2011-2012, one of the Capstone projects that I put together was a smartphone-controlled switch for use in IoT applications. This project had many commercial applications, and I found a group of Capstone students that were interested in working on this device and entering the NVC. The team did a great job building the product and also placed second in the 2012 NVC, after which they founded a company (Zuli, Inc) and commercialized the device.

Since then, I've had 4 other Capstone teams enter the NVC, of which one took 2nd place and another took 4th place in the 2020 Competition. Both are currently working on commercialization of their products. Since 2012 I've also been actively involved as a mentor for all teams entering the competition, typically providing support on both engineering/technical aspects of their products as well as in intellectual property strategy and procurement.

In addition to supporting NVC teams, from 2011–2014 I also taught a course on Patents and Intellectual Property (IP) in the TMP program. The material for this course drew heavily upon my experience gained from consulting in this area. Since 2014, although I have not been formally working as an instructor in TMP, I have been running IP seminars and workshops fairly regularly for TMP graduate courses as well as for TMP's G2 Summer Accelerator Program.

The remainder of the material below primarily focuses on my work during the current review period.

II. Overview – Current Review Period

As an LSOE in the ECE Department and the only LSOE associated with the Electrical Engineering undergraduate program (the other LSOE in our department is associated with the Computer Engineering program), my primary role is to help all of our EE students obtain the knowledge and skills they need to be successful in their field and in their careers in general. My contributions to this goal are achieved through a combination of:

- Teaching courses;
- Mentorship and advising of undergraduate research projects, particularly freshman design projects and senior Capstone projects;
- Mentorship of student teams in the TMP New Venture Competition and TMP Summer Accelerator program;
- Service as an undergraduate advisor;
- Service on various committees geared towards improvement and updating of curriculum, general improvements to the student experience, and departmental accreditation (ABET);
- Engagement in outside volunteering activities, primarily directed towards STEM related mentorship for elementary and middle school age students in the Santa Barbara area; and
- Engagement in outside consulting work that has kept me up to date on the current state of my field and has also allowed me to provide additional educational and professional opportunities to my students.

A summary of all my responsibilities on a quarter-by-quarter and ongoing basis during the current assessment period are provided in the table below.

Date / Quarter	Type of Responsibility	Description
F2018	Teaching	Instructor for ECE 188A and ECE 132.
W2019	Teaching	Instructor for ECE 188B and ECE 120A. Co-instructor for ECE 5.
S2019	Teaching	Instructor for ECE 188C and ECE 120B.
F2019	Teaching	Instructor for ECE 188A.
W2020	Teaching	Instructor for ECE 188B and ECE 120A. Co-instructor for ECE 5.
S2020	Teaching	Instructor for ECE 188C and ECE 120B.
Ongoing	Lab Support	Maintain Capstone Lab space.
Ongoing	Committee work	Service on various ECE dept and CoE committees.
Ongoing	ABET support	Prepare accreditation assessments and reports.
Ongoing	Advising	Undergraduate advisor for approximately 40-50 EE undergrads.

During the current assessment period (September 2018 – Present), my teaching responsibilities at UCSB have included (i) running the EE Capstone projects course (ECE 188), (ii) co-teaching the Freshman EE Design Projects course (ECE 5), and (iii) teaching courses related to semiconductor device physics, including ECE 132 (Solid-State Electronic Devices) and the ECE 120A/120B design sequence, which focuses on semiconductor device design, fabrication, and testing, and includes design and fabrication labs completed in the UCSB Instructional Cleanroom. With the exception of ECE 132, all of the courses I teach are design courses involving a substantial lab component, and so I spend a lot of time outside of class helping individuals and small groups with their lab projects as well as maintaining the lab facilities.

As indicated above, in addition to my teaching assignments at UCSB, I have continued to engage in activities outside of the University that I believe also have a positive impact on my teaching outcomes. These activities include participating in STEM related mentorship events for elementary and middle school age students in the Santa Barbara area, as well as consulting work in patents and intellectual property for several local companies. The latter has enabled me to introduce material to students in both the Engineering Capstone programs and various TMP programs that are highly relevant to their careers, as further described below.

A few accomplishments during the past 2 years that I believe stand out and that I am particularly proud of are as follows:

1. After steadily growing the EE Capstone sequence (ECE 188ABC) since 2009, in 2019-2020 it was for the first time required for all undergraduate EE majors. While the number of students in 2019-2020 was about double that of previous years and included students that in previous years would not have even qualified to take the sequence, the quality of the program and the quality of work on the students' senior Capstone projects remained at the same high level that I had built the program to.

2. In order to expand the experience of students in our ECE department and in the College of Engineering in general, I have for a number of years worked with the TMP program to provide a path by which students could enter their Capstone projects in the TMP New Venture

Competition (NVC). In 2019-2020 I helped to establish and then mentored 2 NVC teams based on senior Capstone projects. The first, based on a 2018-2019 EE/ME multidisciplinary Capstone project known as LegTrek, was led by 2 of my EE students from the LegTrek project that remained at UCSB during the 2019-2020 year to complete their Masters degrees. This team, which had designed and built an assistive walking device to help improve the everyday lives of people with reduced or impaired mobility, took 2nd place in the competition and was awarded $7500. For the second, I personally proposed, sponsored and provided mentorship for a 2019-2020 Mechanical Engineering capstone project to design and build a novel easy-to-use compression sock for prevention of deep vein thrombosis (DVT). This team, which dubbed themselves Thermaform Technologies, took 4th place in the competition and also won the People's Choice Award and the Best of Fair Award, all of which resulted in them taking home $8000 in winnings.

Below is a detailed summary and assessment of my activities in each of the above stated categories. Also included below is a discussion of the extra measures and modified course activity that I enacted in response to the COVID-19 closure of the physical facilities at the University.

III. Teaching Activities

A. EE Capstone Program

Running the EE Capstone Program is the largest of my teaching responsibilities. I was first placed in charge of the EE Capstone Senior Project course sequence (ECE 188ABC) in 2009-2010. This course had previously only been offered somewhat informally, and the ECE department was interested in expanding the course and potentially making it a requirement for all EE students at some point in the future. Because the course was intended to attract students interested in a wide range of EE topics, the goal was to structure the course in such a way that students would have a wide array of project options to choose from. Over the years that I have taught ECE 188, the course grew from 8-9 students/year working on ~3 projects during the first year to ~20-25 students/year working on 5-7 projects each year prior to 2019, and now also includes multi-disciplinary projects completed in conjunction with students in the Mechanical and Computer Engineering programs. Projects have been directed to a wide range of areas within EE, including embedded systems, image processing, digital and analog circuit design, signal processing, sensors, wireless communication, antenna systems, optical detection, control systems, and many others.

This course was quite a challenge to build and continues to be challenging to maintain. Unlike other courses, in which curriculum typically only undergoes minor changes from year to year, the Capstone course involves a new set of projects and partners every year, and many of the projects involve new or developing technologies. In order to establish projects for the students each year, I solicit faculty members, researchers, companies, and individual sponsors to identify potential projects that would be suitable for students and that the sponsor is willing to fund (since university funding for the program has been extremely limited). Because the projects cover a wide array of sub-fields within the electrical engineering discipline, it is often quite a challenge to properly identify projects that are suitable in scope for the course and to choose/identify a technical mentor for the group (the latter has been particularly difficult for projects that are sponsored by research groups outside of the ECE department).

In addition to directing the projects and providing technical mentorship to the students, I also spend a lot of time working with them on other important skills such as team management and presentation skills (both written and oral). I've found that students' ability to present the material they are working on in a variety of different formats (2-minute elevator pitch, 10-minute technical overview, 45-60 minute detailed technical talk, 5-15 minute presentation to a general audience) is more strongly correlated to their individual and team performance and success rate on these projects than any other metric. I have each team do 2 presentations plus a prototype demo every quarter, and I provide specific feedback individually to each team on what the students could do better in future presentations, with the goal being that by the end of the academic year every student is able to give professional level presentations. While this involves quite a bit of work on my end, I believe that the skills the students obtain from this is critical to success in their future careers and is something that we as a department and as a university in general are not otherwise doing an adequate job in building up.

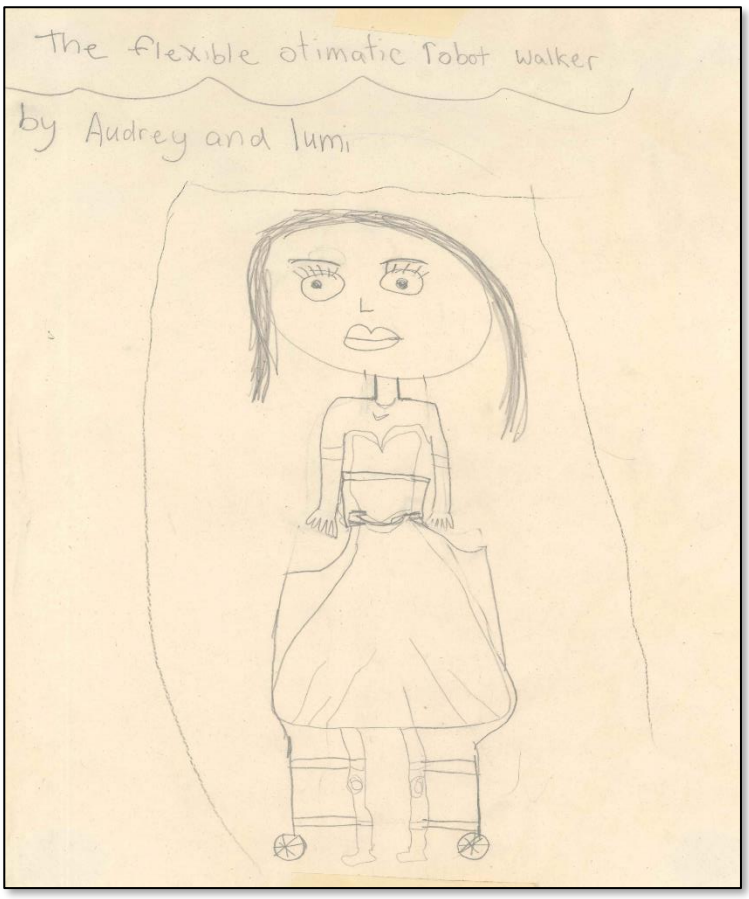
At the conclusion of Spring quarter every year, we (meaning the ME and CE Capstone instructors and I) hold a large Engineering Design Expo featuring all of our Capstone projects that is typically attended by about 500-600 people from local industry and from our campus. Capstone teams all present posters and demo their projects, and several teams give TED-type talks to a large audience in Campbell Hall. A panel of experts from academia and industry judge the projects and select award winners. This event is a great source of pride for the students who participate, and helps us engage with and further solidify our relationships with all of our industry partners, many of whom hire lots of our graduating students. Due to the shutdown in Spring 2020, we were not able to hold this event in its usual format. Instead I held a virtual EE Capstone Expo over Zoom that was attended by about 100 participants to feature the students' work and to celebrate with them. The students were very appreciative of this, as I think it provided them with a sense of accomplishment and closure and gave them something to be proud of in the midst of the pandemic.

Several years ago, the ECE Department decided to make the ECE 188 Senior Capstone sequence a requirement for all EE majors. 2019-2020 was the first year in which EE seniors were all required to take the course, and so we had 46 students working on 11 projects (and are expected to have ~70 students for 2020-2021). During the 2 prior years, I chaired the EE Capstone Committee and spent a considerable amount of time preparing to scale to a much larger Capstone course in order to ensure its continued success, including preparation of a proposal for resource allocation that was approved unanimously by the ECE Department. Below is a summary of course outcomes and notable achievements for the EE Capstone program in each of the 2 years corresponding to this review cycle.

During the 2018-2019 academic year, I oversaw 20 EE seniors working on 5 different Capstone projects (2 multi-disciplinary and 3 EE projects). Four of these were industry partnered projects, while one was a special project to build an assistive walking device for a local 7th grade girl with cerebral palsy. During the 2019-2020 academic year, the first year that ECE 188 was required for all EE's, I oversaw 46 EE seniors working on 11 different Capstone projects (3 multi-disciplinary and 8 EE projects). Five of these were industry partnered projects, five were research lab partnered projects, and one was an entry in the FAR/Mars Rocket Competition. For all of the projects completed over these 2 years, I feel like the students gained a tremendous amount of experience and knowledge that will benefit them in their future careers. A few highlights and notable achievements are as follow:

(a) In order to support all of the projects and other course activities, I was able to raise about $125,000 in cash and in-kind donations (see my current bio-bib for details).

(b) One of the multidisciplinary projects that was run between myself and ME Capstone instructor Tyler Susko in 2018-2019 was proposed by a local 7th grade girl named Lumi (she also goes by Sophie) who has triparetic cerebral palsy. Lumi uses a power chair for mobility, but would really like to walk because she dreams of one day owning a bakery. She and a friend came up with an idea for an assistive walking device (see picture below), and she asked us if our students could build this device for her:



After I managed to obtain about $11K in funds to get the project started, we assembled a team of 5 EE and 6 ME undergraduates. The team spent the year working with Lumi, her mother, and her physical therapist to design and build a device that would safely provide Lumi with the mobility she desired. A video featuring Lumi walking in her device, which the team named LegTrek, can be found at:

https://capstone.engineering.ucsb.edu/projects/legtrek

After the test walk featured in the video, Lumi declared that she liked the LegTrek device much more than her power chair!

Because of the positive feedback received from Lumi, her mother, and her physical therapist Jane Harper, we thought that there might be a real commercial market for such a device. Several of the EE students who were staying at UCSB for 1 more year to complete their Masters degrees decided to enter the 2020 TMP New Venture Competition (NVC), and I agreed to mentor them. I met regularly with the team throughout the 2019-2020 academic year to provide them guidance and feedback, and helped them file a patent application for their device. The team did an outstanding job in the competition and took second place overall. They are now participating in UCSB's G2 Summer Accelerator program and continuing work on the commercialization of the device.

(c) In 2019-2020, the first year that the ECE 188 sequence was required for all of our seniors, we were extremely successful at scaling the program, and the projects were on par with the high level of excellence that we had grown used to in previous years. However, as the shelter in place order was issued at the end of winter quarter, we had to quickly adapt to our new reality. Namely, that these projects that the students had put so much time and effort into might need to come to an end several months prematurely, and that our end-of-year event and celebration would surely be canceled.

After I held multiple Zoom meetings with each team to discuss options for Spring quarter, each team came up with a plan for completing at least sub-portions of their projects while working remotely. And while it was tempting to call off the end-of-year event, I decided to hold a virtual EE event in order to keep the students motivated to see at least a portion of their projects through to the end. I honestly expected most of the students to thoroughly disengage, as it didn't seem to me that students would be terribly motivated to continue with their projects under these conditions. Nevertheless, I continued to meet with the teams individually every week over Zoom.

By the end of the quarter, I was quite amazed at how much progress every group was able to make. Although only a few teams were able to complete their projects (it was quite amazing that any of them finished), all of the teams ended Spring quarter with something that they could show off and be proud of. Our virtual EE Capstone Expo ended up being a very exciting event for all of our students and everyone who attended, and really provided a sense of accomplishment and closure for all of our graduating seniors.

The mean scores from my student evaluations for each of the 6 quarters that I taught ECE 188 during the current review period are listed in the table in Section E below. As seen, with the exception of Spring 2020 (during which the course was taught remotely due to COVID-19), my scores every quarter were substantially better than both the departmental and university averages. If Spring 2020 scores are omitted, my student-weighted average score for Quality of Teaching was 1.31 (ECE department and entire university averages are both 1.9), and my student-weighted average score for Quality of Course was 1.38 (ECE department average is 1.8 and entire university average is 2.0). Additionally, scores were about the same for the 2018-2019 and 2019-2020 academic years, indicating that students remained equally enthusiastic about the course even after it was scaled in size due to being switched from an elective to a required course.

B. ECE 120A/120B Design Sequence

I have taught ECE 120A and 120B (previously numbered ECE 124B and 124C, respectively) almost every year since I became an instructor in the ECE Department at UCSB in 2004. This design sequence is intended to train undergraduates in semiconductor device fabrication in a cleanroom environment, as well as wafer-level integrated circuit design, layout, fabrication, and testing. At the time I began teaching these courses, while the ECE 120A (124B) course had attracted a fair number of undergraduates (typically ~15/year), there had previously only been little interest among students in ECE 120B (124C) (to the best of my knowledge, no more than 5 or 6 students had ever enrolled in ECE 124C prior to 2004). Since I began teaching these courses, the course size for ECE 120A has consistently been at least about 30 students per year (about 2 times its previous size), and enrollment in ECE 120B has been between 17 and 26 students ***each year***, which is about 4 times larger than the maximum class size prior to the time that I took over this course. An average of about 2-3 students per year have continued on to graduate school programs involving semiconductor fabrication. Additionally, I have helped place numerous students who have taken these courses in Engineering department research groups (particularly Umesh Mishra's and John Bowers' groups) as well as in local industry positions. I regularly receive solicitations from companies which are looking for entry level engineers to work in semiconductor device fabrication, design, and testing, and I have typically helped place about 2-3 students per year in these positions. Many of these companies are in the Santa Barbara area, and some were founded by UCSB faculty or alumni, including Soraa, Aurrion, Transphorm, Raytheon, Santa Barbara Focal Plane (Lockheed Martin), and Calient.

During the 2018-2019 and 2019-2020 academic years, even more students were drawn to these courses, indicating that the popularity of these courses was still continuing to grow. ECE 120A had 38 students in 2019 and 40 students in 2020, which was about 25% more students than in any previous years. Consequently, I had to work closely with the course TA's and with the cleanroom lab manager Bob Hill to ensure that we could structure the labs in such a way that everyone could safely and effectively complete the labs. In 2020, we fortunately managed to increase the efficiency of the lab to the point that students were in fact able to complete the lab work for their final projects prior to the shelter in place order going into effect.

ECE 120B had an enrollment of 29 students in 2018-2019, also a record number of students for that course. In 2019-2020, the shelter-in-place order meant that we would not be able to complete the circuit fabrication and testing portions of the lab, which was what most of the students really look forward to in that course. As a result, in addition to adapting to teaching the course lectures online, I had to completely restructure the lab projects to be individual projects (rather than group projects) and create a new set of labs focusing on circuit design, simulations, and physical layout. This format, while being the best solution under the circumstances, was clearly not ideal. So while originally 32 students were registered for the course, approximately half of them informed me during the first week that they would be dropping the course and taking it the following year when they would (hopefully) be able to complete the regular lab portion of the course.

As seen in the table in Section E below, with the exception of Spring 2020 (during which the course was taught remotely due to COVID-19), my student evaluation scores for these courses every quarter were substantially better than both the departmental and university averages. If Spring 2020 scores are omitted, my student-weighted average score for Quality of Teaching was 1.57, and my student-weighted average score for Quality of Course was 1.41.

C. ECE 5

I began co-instructing the Freshman EE Design Projects course (ECE 5) in 2019 and was a co-instructor both in that year and in Winter of 2020. In ECE 5, students work in groups of 2-3 to build and program an Arduino-based device that they design, and they present and demo their final devices at a showcase that the other instructor and I organize for them at the end of the quarter. This class is quite a challenge, as it is the first engineering lab course that EE students take, and the enrollment is around 100 students, meaning that we had about 32 projects each year that required guidance and mentoring. Many of the projects require some knowledge of control systems, feedback loops, sensors, power electronics, and other topics that the students have not yet learned, and so we introduce many of these topics on the fly as the students encounter them in their projects. While this at times can be a bit exhausting, this course has been extremely valuable and effective at introducing the students to true electrical engineering design, as well as getting them excited and motivated for some of the more abstract course material that they learn early on and would otherwise not be able to appreciate until long after the completion of these courses.

In Winter 2020, the shelter in place order took effect about 1 week before students were to complete their projects and present them at our showcase. Although we had to cancel the showcase, students were able to compete their projects and present them to us in video format.

As seen in the table in Section E below, my student evaluation scores for these courses every quarter were better than both the departmental and university averages. My student-weighted average score for Quality of Teaching was 1.76, and my student-weighted average score for Quality of Course was 1.58.

D. ECE 132

ECE 132 is a required course for all EE undergraduates, and is the first upper-division engineering course that many of our students take. Of all the courses I teach, I find this one has the largest percentage of students who really struggle to understand the subject material. I'd say about half the class comes out understanding it at least reasonably well, another quarter understand it somewhat well, and about a quarter have what I would consider a sub-par understanding. The ones who tend to understand it well seem to really enjoy it, as they tend to subsequently enroll in my ECE 120A/B sequence, which has high enrollment for an elective sequence and builds on material from this course. Nevertheless, in Fall 2018 my student evaluations for this course (shown in Section E below) were a bit worse than in my other courses. I previously taught this course in Fall 2017 and received similar evaluations. In reading over student comments at the time, the largest complaint was in the quality and accuracy of the course note set that I had posted on the course website (which I had received from a previous instructor of the course and had been provided in all previous years the course was taught). For Fall 2018, I completely rewrote the note set, and subsequently did not receive any student comments about them.

I reviewed the student comments for Fall 2018 to try to determine which aspects of the course or my teaching students didn't like, but found it very difficult to draw conclusions due to a lack of consistency in responses. For example, when asked to comment on the quality of the lectures, 5 of 13

respondents generally thought the lectures were very good or great, 6 of the respondents thought they were in a range of OK to good, and 2 of the respondents thought they were poor.

My general conclusion based on both examination of my evaluations and in speaking to students who took the course is that the subject matter of the course is generally of great interest to students pursuing the electronics and photonics track in our department, but many of the students pursuing other tracks generally do not like the course material and subsequently do not take more courses in this area of electrical engineering. The student that do enjoy the course take the ECE 120AB sequence that I teach (described above), and have generally given me very high marks in those courses. Given that those courses in 2019 and 2020 had a larger number of students than in previous years (and enrolled a larger percentage of students from our department than in previous years), it appears that a larger number/percentage of our students really enjoyed the course as compared to previous years, and those that did not voiced their displeasure. In conclusion, I think that while there are certainly more improvements that I could make in teaching this course, to a large extent the course material is like black licorice; not everyone likes it, but those who do like it a lot.

E. Course Evaluations

For reference, below is a table summarizing student evaluations for each of the courses described above. For each course, the students rate both (i) the Quality of the Instructor's Teaching and (ii) the Quality of the Course on a scale of 1 to 5, where 1 is excellent and 5 is poor. The average score in the ECE Department for Question (i) is 1.9 (entire campus average is also 1.9), and the average score in the ECE Department for Question (ii) is 1.8 (entire campus average is 2.0). Commentary on these scores for each course that I taught is provided in each of the sections above.

Course	Quarter	Quality of Instructor's Teaching (Mean Score)	Quality of Course (Mean Score)	Number of Responses
ECE 188A	F18	1.4	1.4	18
ECE 188A	F19	1.3	1.4	41
ECE 188B	W19	1.3	1.4	13
ECE 188B*	W20	1.4	1.5	27
ECE 188C	S19	1.0	1.0	12
ECE 188C**	S20	1.8	1.9	9
ECE 120A	W19	1.6	1.5	21
ECE 120A*	W20	1.3	1.1	11
ECE 120B	S19	1.7	1.5	18
ECE 120B**	S20	2.0	2.0	3
ECE 5	W19	1.8	1.5	53
ECE 5*	W20	1.7	1.7	39
ECE 132	F18	2.1	2.3	42

Notes:

* University was shut down in Week 10 due to COVID-19

** Entire course taught remotely due to COVID-19

IV. University Service and Other Teaching Contributions

A. Technology Management Program

For many years I have served as a mentor/advisor and have given guest lectures to students in the UCSB Technology Management Program. Most of the mentorship has been in the areas of Intellectual Property, technical product development, and project management. Some of my specific contributions during the past 2 years are as follows:

- Mentor for students participating in the TMP G2 Summer Accelerator program
- Advisor/mentor for New Venture Competition participants
- Helped several NVC teams file patent applications
- As described earlier, I advised and mentored 2 Engineering Capstone teams that entered the 2020 New Venture Competition and were amongst the 5 finalists

B. University Service

As previously described, during the last 2 years I have chaired the ECE Capstone Committee and led the effort to scale the EE Capstone course. I have also served on the ECE Undergraduate Curriculum and Affairs Committee. For most of the 2019-2020 academic year, the curriculum committee has worked on a plan to better modernize and substantially overhaul the ECE undergraduate curriculum. We have been meeting weekly for some time now (including over Zoom beginning this past Spring), and I have also put in a fair amount of work and preparation between meetings. At the time of writing of this document, we are about ready to present the proposal to the entire ECE faculty. I have also served on the College of Engineering ABET ad-hoc committee, for which I have completed a number of assessments and other reports that have contributed to the ongoing efforts required to maintain our accreditation. Finally, I serve as one of the undergraduate advisors in our department. I advise about 15-20 students per year on their senior elective choices in order to help them formulate a program that best suits their interests within the broad field of electrical engineering.

V. Outreach and Volunteering

I try to volunteer in as many science mentorship opportunities as I'm able to fit into my schedule. During each of the last 2 years, I have served as a science fair mentor for 8th graders at local junior high schools. I am also an advisor board member for Youth Innovation Club, a local non-profit organization that promotes STEM education and provides programs STEM-based programs for 4th through 8th graders.

VI. Course Material Adapted from IP Work

Through consulting work that I've performed for local tech companies in the area of patents and intellectual property, I've gained extensive knowledge in these fields and have developed course material that I present to students in the EE, CE, and ME Capstone courses as well as to students in the Technology Management Program via IP lectures and workshops focusing on patents and trademarks/branding. In the Engineering Capstone program, I've even managed to incorporate some of this material into the students' work on their projects. One of the lectures that I give to the Capstone students is focused on trademarks and branding, including how companies in several market segments go about developing their brands. We then have the students apply these branding techniques to the products that they are building and develop a logo and branding strategy. The students have really enjoyed this, and all of the logos they developed can be found along with their associated project documentation on the Projects page of our Capstone website:

https://capstone.engineering.ucsb.edu/projects

VII. Conclusion

Overall, I feel like I have continued to maintain a high level of performance in my teaching and associated activities within the ECE Department. I am passionate about teaching and mentoring students, and look forward to continue improving the experience and opportunities of all the students in our program.